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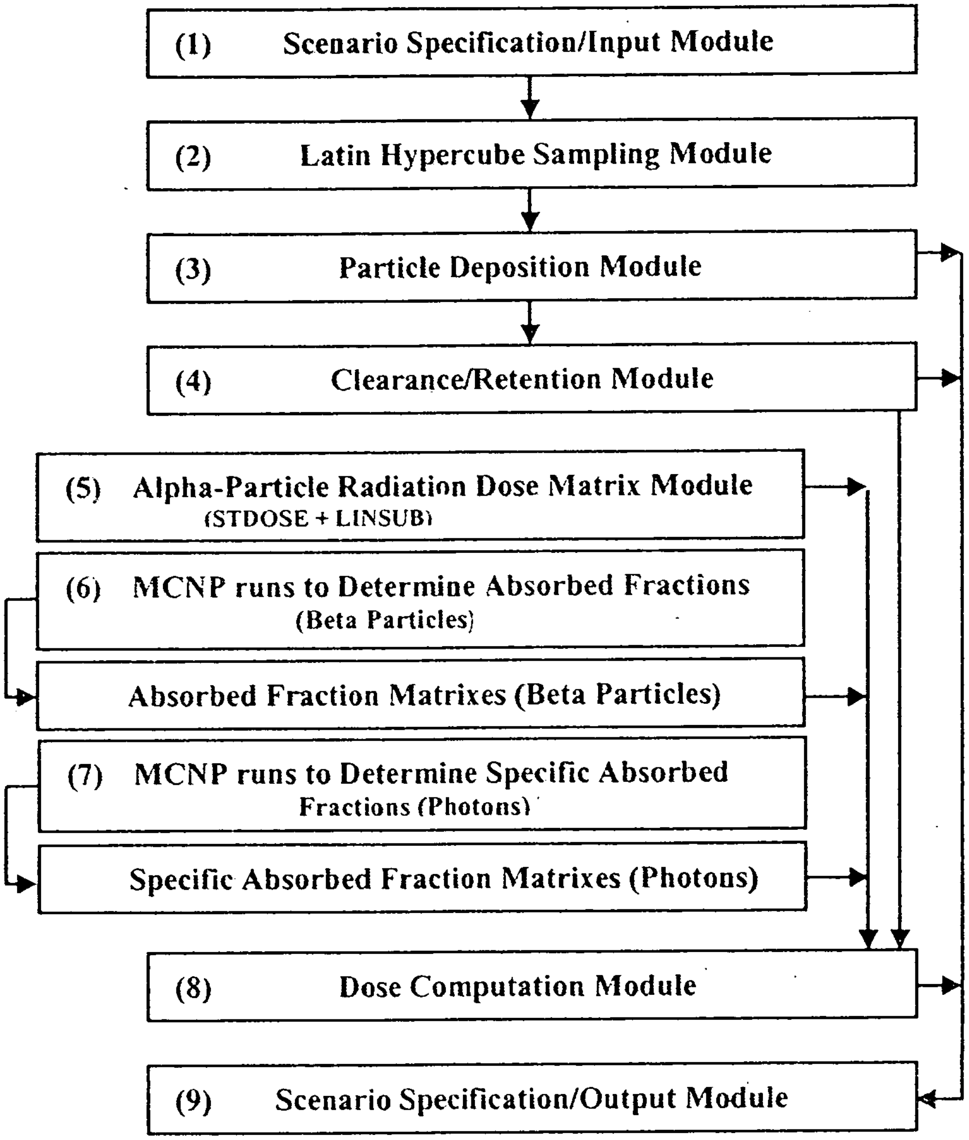
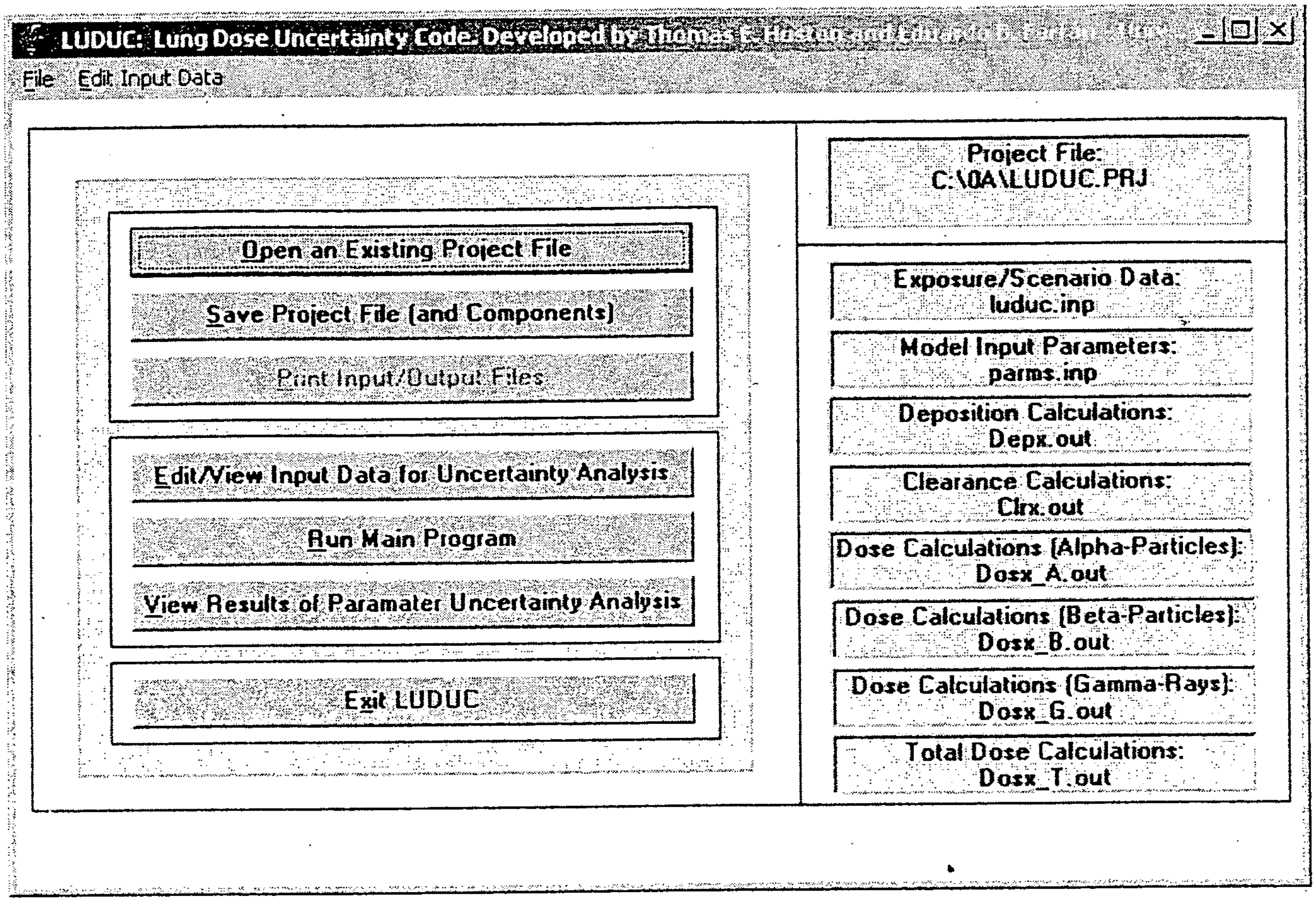

(1) Scenario Specification/Input Module
(2) Latin Hypercube Sampling Module
(3) Particle Deposition Module
(4) Clearance/Retention Module
(5) Alpha-Particle Radiation Dose Matrix Module
(STDOSE + LINSUB)
(6) MCNP runs to Determine Absorbed Fractions
(Beta Particles)
Absorbed Fraction Matrixes (Beta Particles)
(7) MCNP runs to Determine Specific Absorbed Fractions (Photons)
Specific Absorbed Fraction Matrixes (Photons)
(8) Dose Computation Module
(9) Scenario Specification/Output Module

FIG. 1


LUDUC: Lung Dose Uncertainty Code: Developed by Thomas E. Huston and Eduardo B. Farfan [illegible]
File
Edit Input Data
Open an Existing Project File
Save Project File (and Components)
Print Input/Output Files
Edit/View Input Data for Uncertainty Analysis
Run Main Program
View Results of Paramater Uncertainty Analysis
Exit LUDUC

Project File: C:\0A\LUDUC.PRJ

Exposure/Scenario Data: luduc.inp

Model Input Parameters: parms.inp

Deposition Calculations: Depx.out

Clearance Calculations: Clrx.out

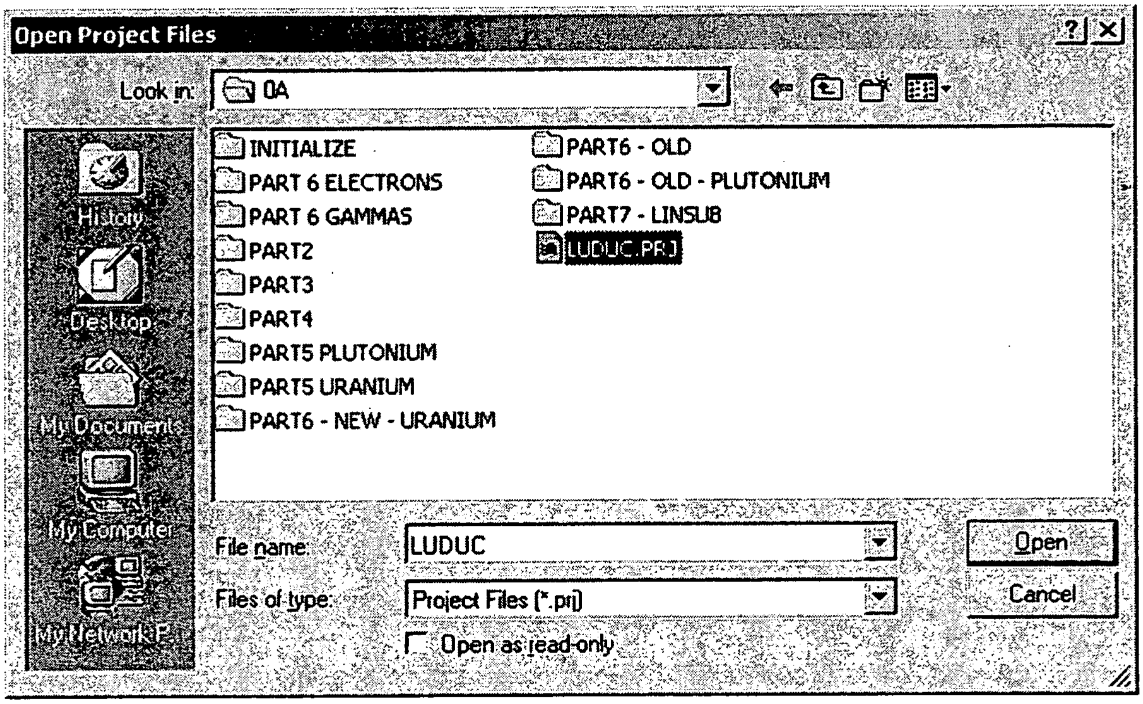
Dose Calculations (Alpha-Particles): Dosx_A.out

Dose Calculations (Beta-Particles): Dosx_B.out

Dose Calculations (Gamma-Rays): Dosx_G.out

Total Dose Calculations: Dosx_T.out

FIG. 2



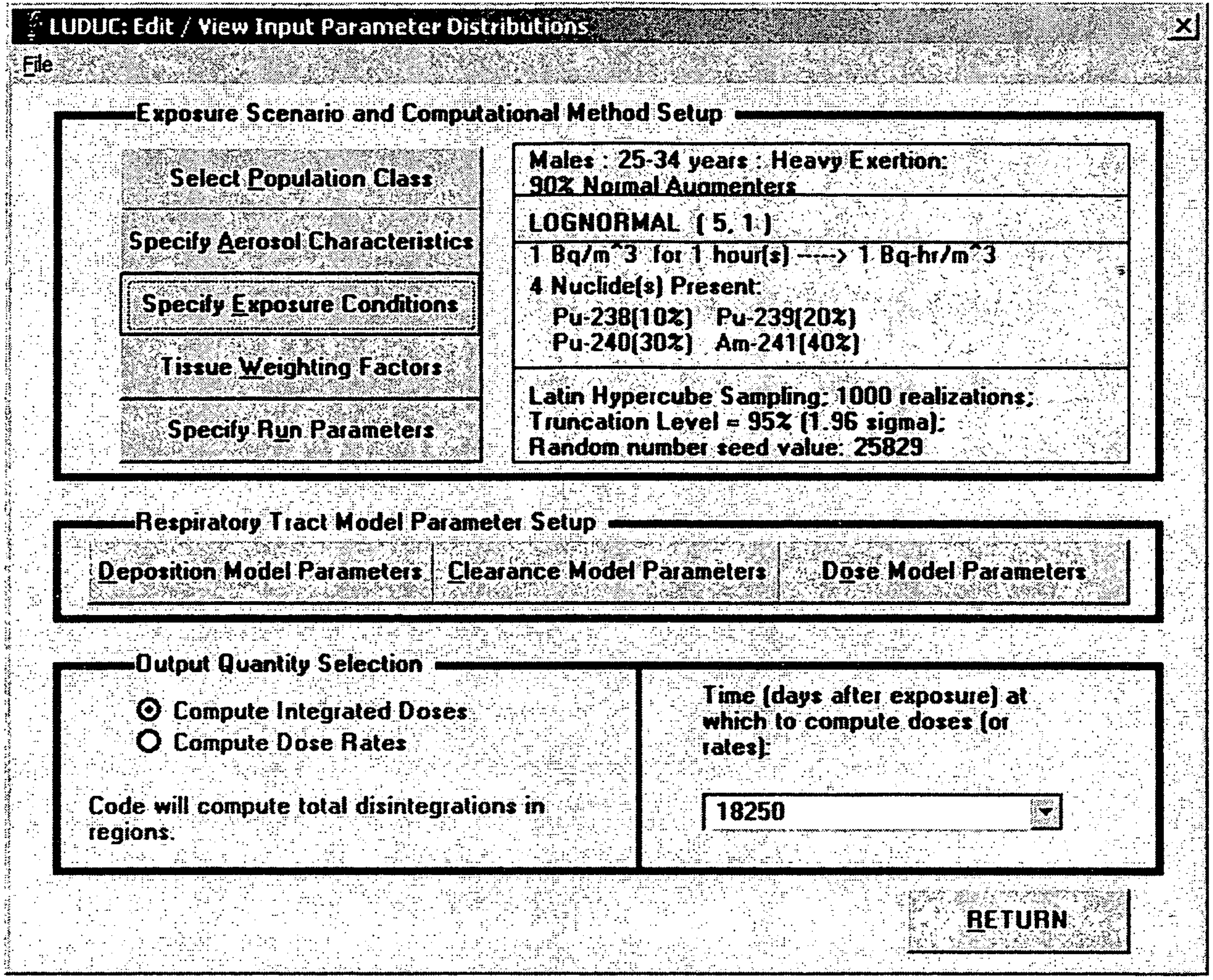
Look in: 0A

File name: LUDUC

Files of type: Project Files (*.prj)

☐ Open as read-only

FIG. 3


LUDUC: Edit / View Input Parameter Distributions
File
Exposure Scenario and Computational Method Setup
Select Population Class
Specify Aerosol Characteristics
Specify Exposure Conditions
Tissue Weighting Factors
Specify Run Parameters
Respiratory Tract Model Parameter Setup
Deposition Model Parameters
Clearance Model Parameters
Dose Model Parameters
Output Quantity Selection
Time (days after exposure) at which to compute doses (or rates):
RETURN

Males : 25-34 years : Heavy Exertion:
90% Normal Augmenters

LOGNORMAL (5, 1)

1 Bq/m^3 for 1 hour(s) ---> 1 Bq-hr/m^3
4 Nuclide(s) Present:
Pu-238(10%) Pu-239(20%)
Pu-240(30%) Am-241(40%)

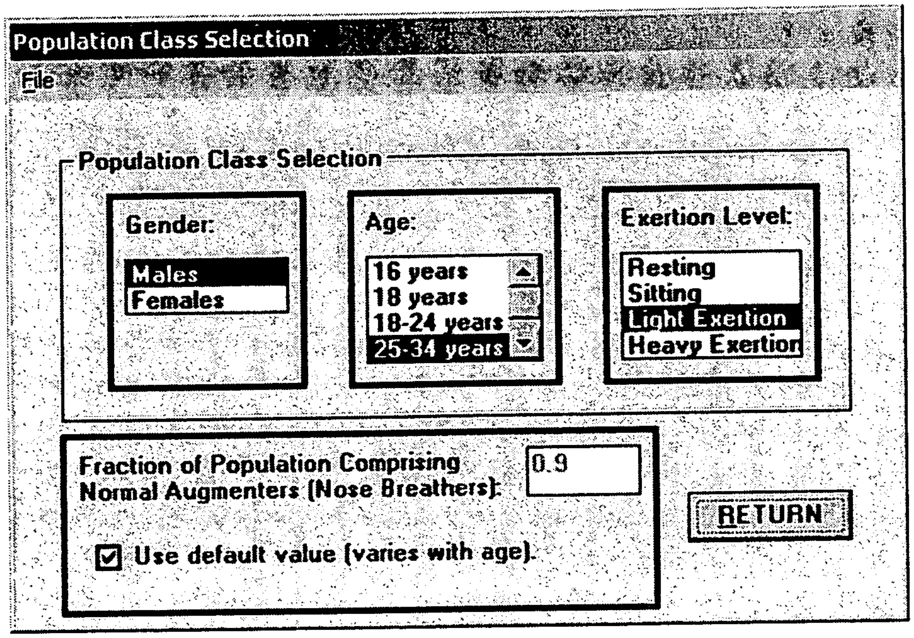
Latin Hypercube Sampling: 1000 realizations;
Truncation Level = 95% (1.96 sigma);
Random number seed value: 25829

⦿ Compute Integrated Doses
○ Compute Dose Rates

Code will compute total disintegrations in regions.

18250

FIG. 4



Population Class Selection

Gender:
Males
Females

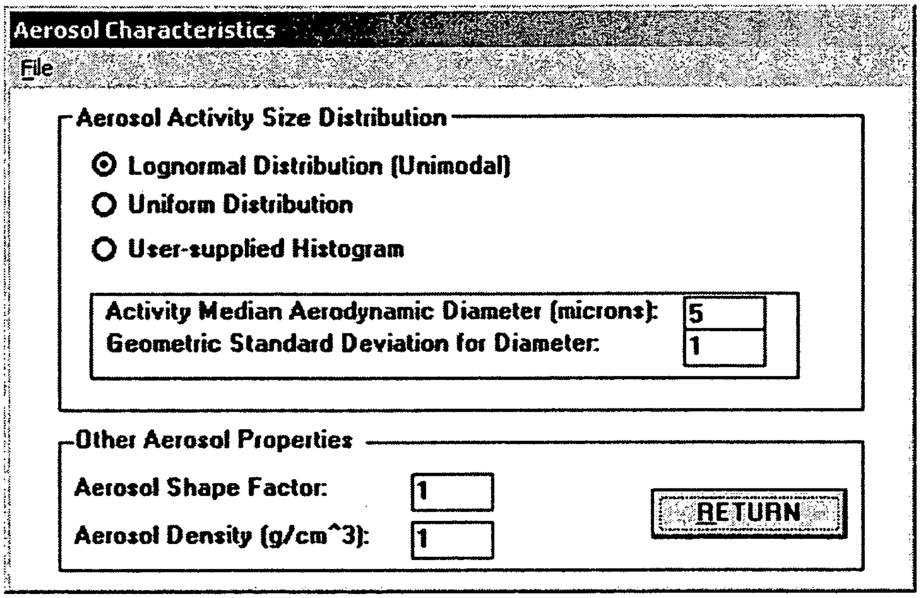
Age:
16 years
18 years
18-24 years
25-34 years

Exertion Level:
Resting
Sitting
Light Exertion
Heavy Exertion

Fraction of Population Comprising Normal Augmenters (Nose Breathers): 0.9

☑ Use default value (varies with age).

FIG. 5



Aerosol Activity Size Distribution

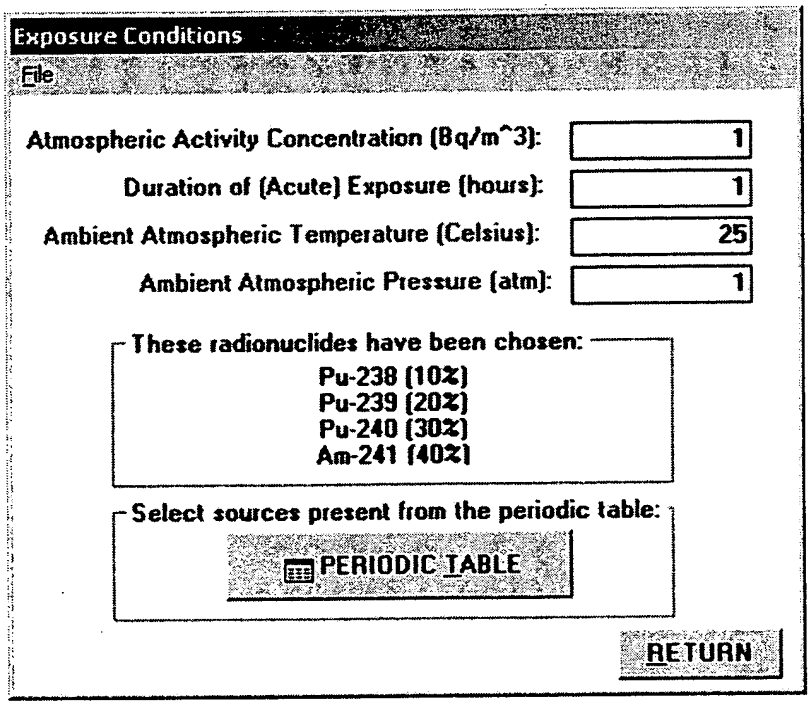
● Lognormal Distribution (Unimodal)
○ Uniform Distribution
○ User-supplied Histogram

Activity Median Aerodynamic Diameter (microns): 5
Geometric Standard Deviation for Diameter: 1

Other Aerosol Properties

Aerosol Shape Factor: 1
Aerosol Density (g/cm^3): 1

FIG. 6



Atmospheric Activity Concentration (Bq/m^3): 1

Duration of (Acute) Exposure (hours): 1

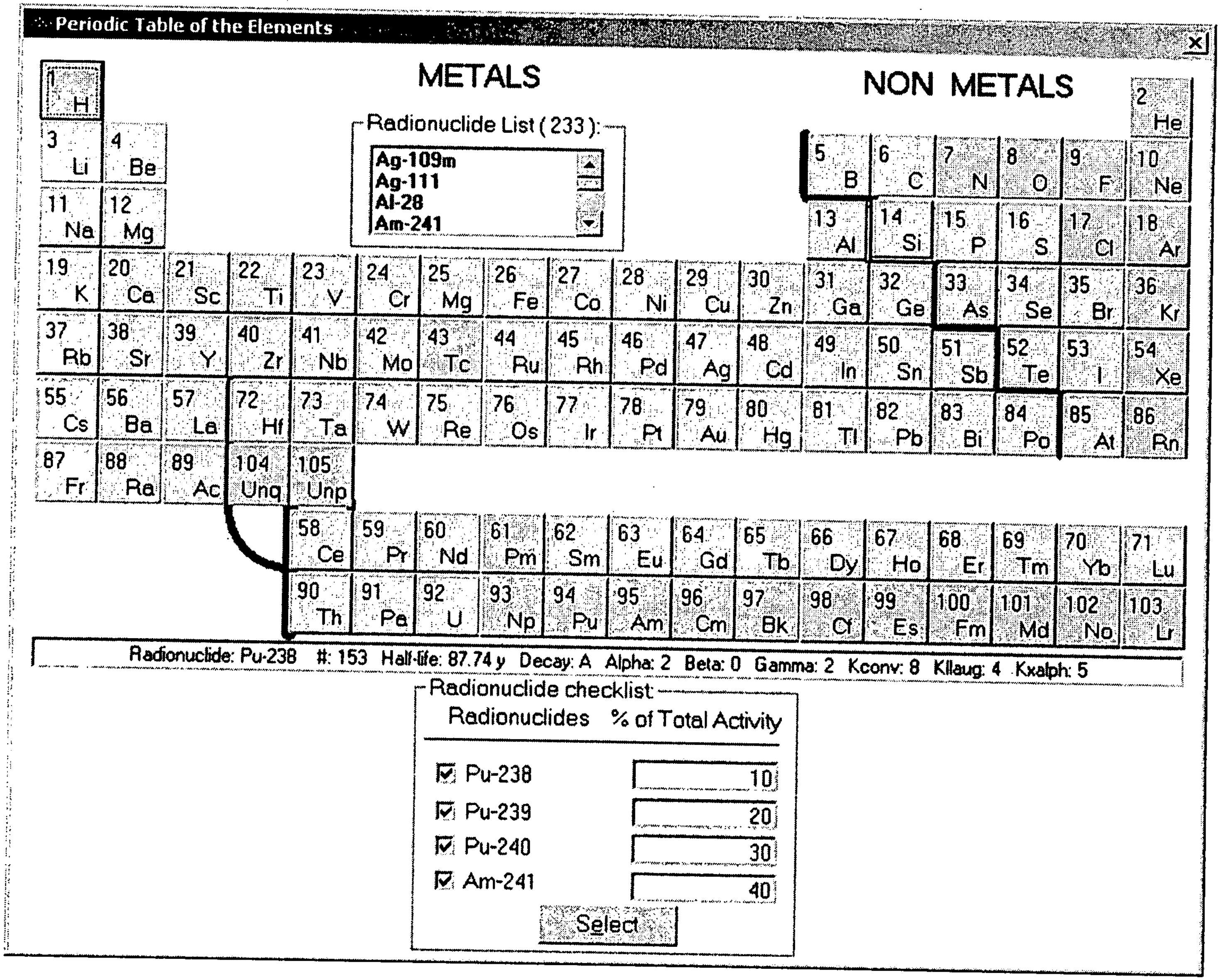
Ambient Atmospheric Temperature (Celsius): 25

Ambient Atmospheric Pressure (atm): 1

These radionuclides have been chosen:

Pu-238 (10%)
Pu-239 (20%)
Pu-240 (30%)
Am-241 (40%)

FIG. 7



Radionuclide List (233):

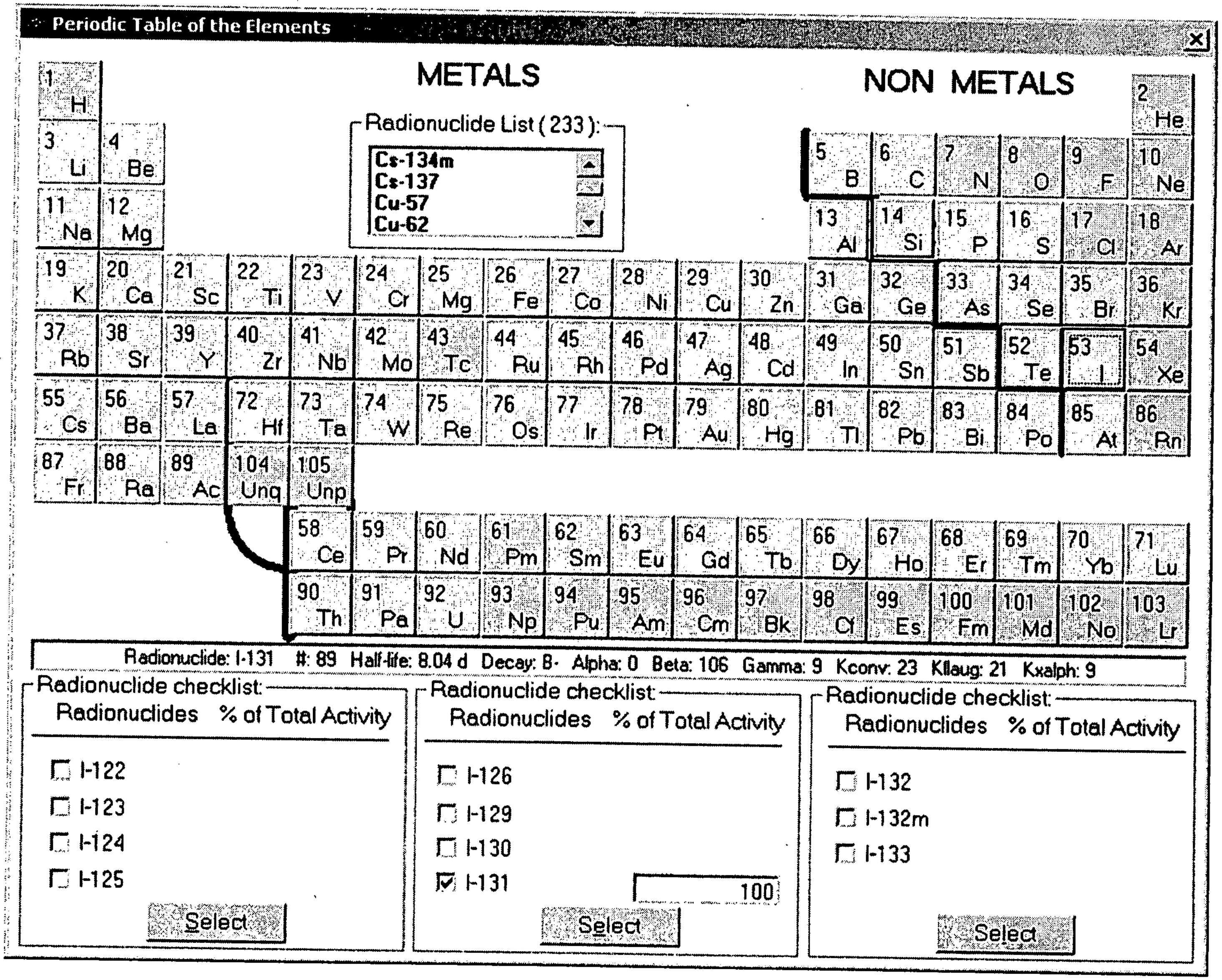
Ag-109m
Ag-111
Al-28
Am-241

Radionuclide: Pu-238 #: 153 Half-life: 87.74 y Decay: A Alpha: 2 Beta: 0 Gamma: 2 Kconv: 8 Kllaug: 4 Kxalph: 5

Radionuclide checklist

Radionuclides	% of Total Activity
☑ Pu-238	10
☑ Pu-239	20
☑ Pu-240	30
☑ Am-241	40

FIG. 8



METALS

NON METALS

Radionuclide List (233):

Cs-134m
Cs-137
Cu-57
Cu-62

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mg	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Unq	105 Unp													
			58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
			90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

Radionuclide: I-131 #: 89 Half-life: 8.04 d Decay: B- Alpha: 0 Beta: 106 Gamma: 9 Kconv: 23 Kllaug: 21 Kxalph: 9

Radionuclide checklist:

Radionuclides	% of Total Activity
☐ I-122	
☐ I-123	
☐ I-124	
☐ I-125	

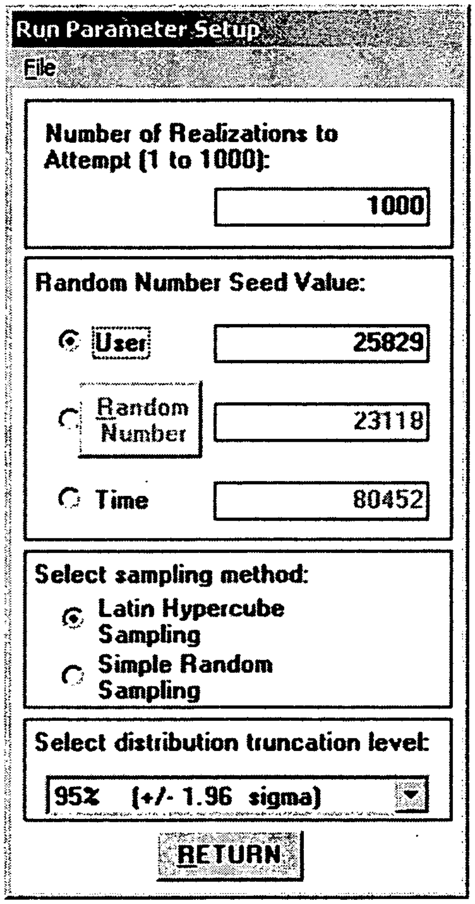
Radionuclide checklist:

Radionuclides	% of Total Activity
☐ I-126	
☐ I-129	
☐ I-130	
☑ I-131	100

Radionuclide checklist:

Radionuclides	% of Total Activity
☐ I-132	
☐ I-132m	
☐ I-133	

FIG. 9



Number of Realizations to Attempt (1 to 1000): 1000

Random Number Seed Value:

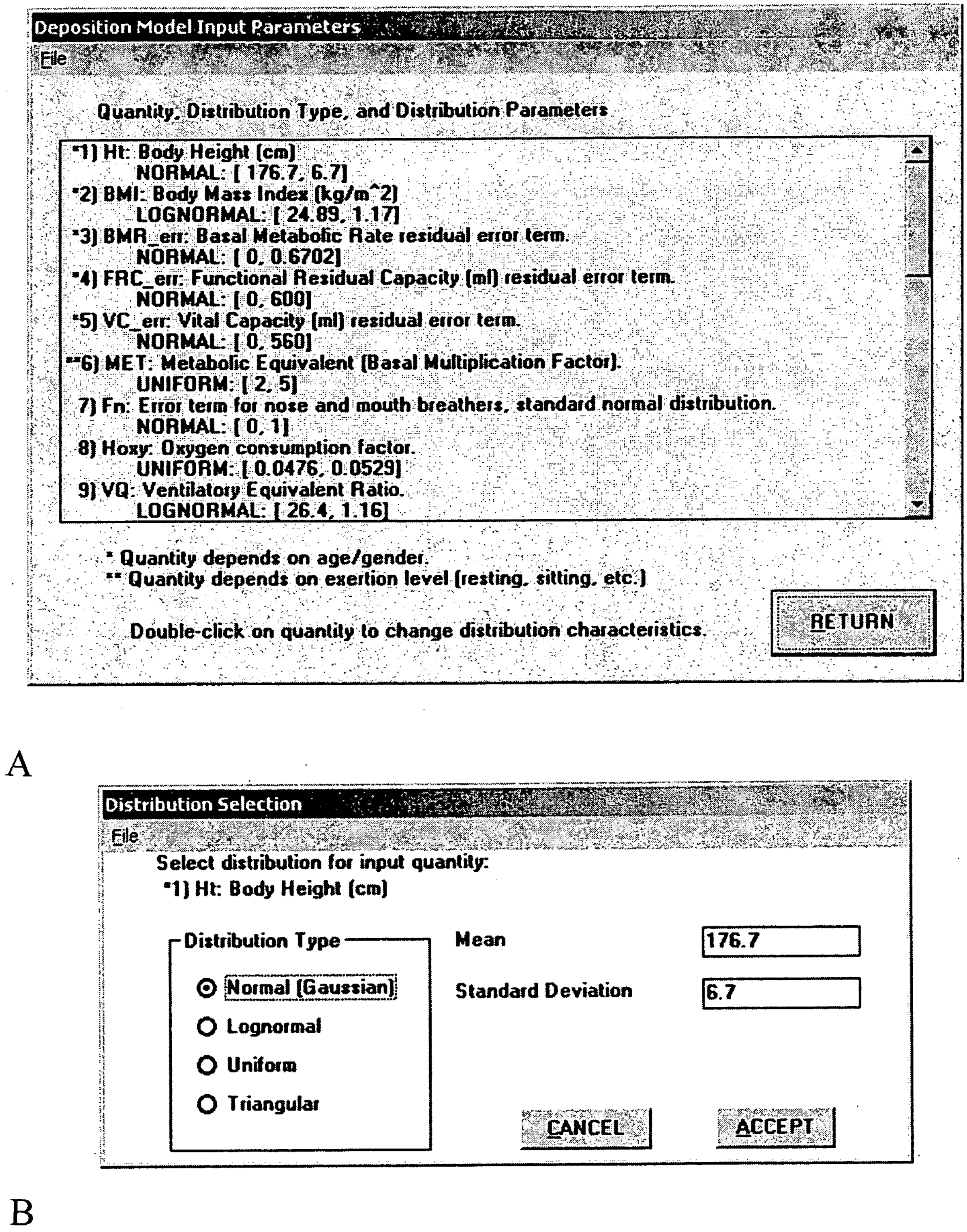
● User 25829
○ Random Number 23118
○ Time 80452

Select sampling method:

● Latin Hypercube Sampling
○ Simple Random Sampling

Select distribution truncation level: 95% (+/- 1.96 sigma)

FIG. 10



Quantity, Distribution Type, and Distribution Parameters

*1) Ht: Body Height (cm)
NORMAL: [176.7, 6.7]
*2) BMI: Body Mass Index (kg/m^2)
LOGNORMAL: [24.89, 1.17]
*3) BMR_err: Basal Metabolic Rate residual error term.
NORMAL: [0, 0.6702]
*4) FRC_err: Functional Residual Capacity (ml) residual error term.
NORMAL: [0, 600]
*5) VC_err: Vital Capacity (ml) residual error term.
NORMAL: [0, 560]
**6) MET: Metabolic Equivalent (Basal Multiplication Factor).
UNIFORM: [2, 5]
7) Fn: Error term for nose and mouth breathers, standard normal distribution.
NORMAL: [0, 1]
8) Hoxy: Oxygen consumption factor.
UNIFORM: [0.0476, 0.0529]
9) VQ: Ventilatory Equivalent Ratio.
LOGNORMAL: [26.4, 1.16]

* Quantity depends on age/gender.
** Quantity depends on exertion level (resting, sitting, etc.)

Double-click on quantity to change distribution characteristics.

A

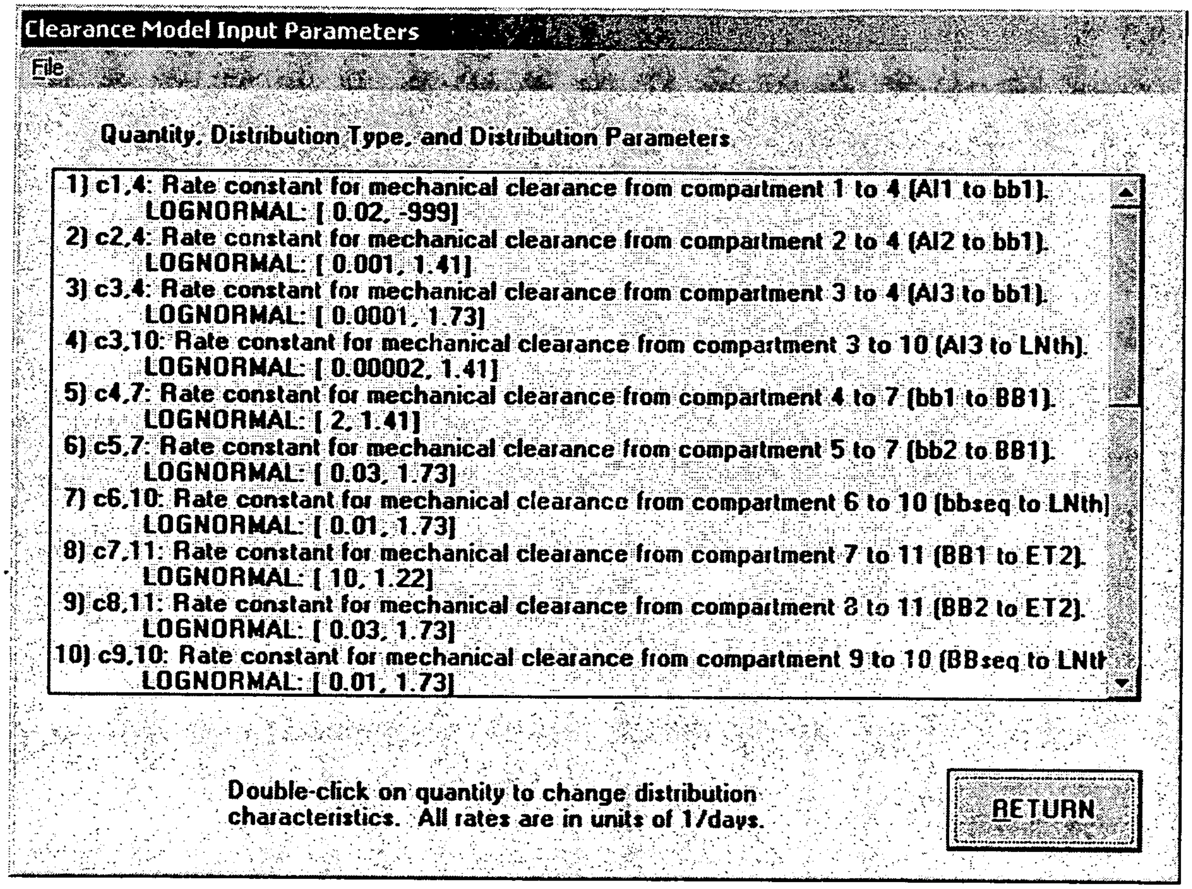
Select distribution for input quantity:
*1) Ht: Body Height (cm)

Distribution Type
- ● Normal (Gaussian)
- ○ Lognormal
- ○ Uniform
- ○ Triangular

Mean: 176.7
Standard Deviation: 6.7

B

FIG. 11

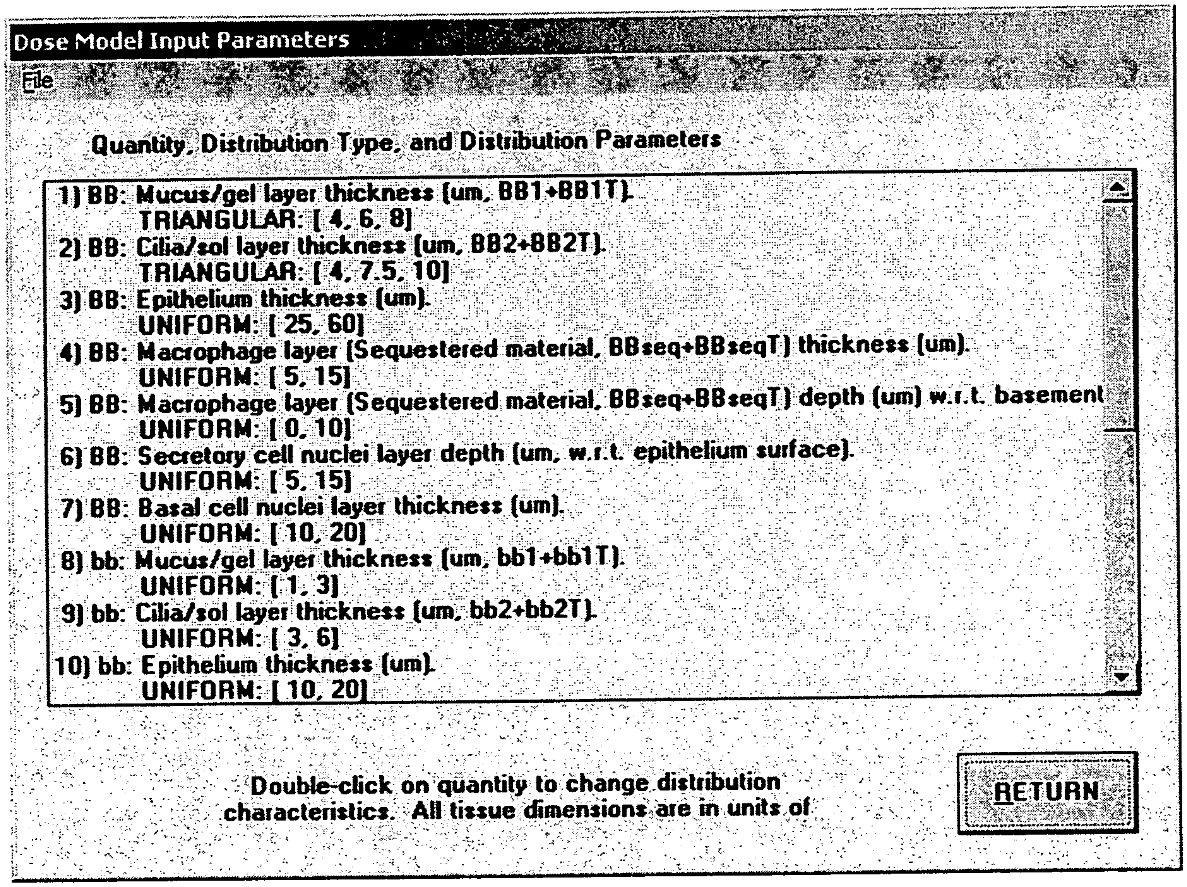


Quantity, Distribution Type, and Distribution Parameters

1) c1,4: Rate constant for mechanical clearance from compartment 1 to 4 (AI1 to bb1).
LOGNORMAL: [0.02, -999]
2) c2,4: Rate constant for mechanical clearance from compartment 2 to 4 (AI2 to bb1).
LOGNORMAL: [0.001, 1.41]
3) c3,4: Rate constant for mechanical clearance from compartment 3 to 4 (AI3 to bb1).
LOGNORMAL: [0.0001, 1.73]
4) c3,10: Rate constant for mechanical clearance from compartment 3 to 10 (AI3 to LNth).
LOGNORMAL: [0.00002, 1.41]
5) c4,7: Rate constant for mechanical clearance from compartment 4 to 7 (bb1 to BB1).
LOGNORMAL: [2, 1.41]
6) c5,7: Rate constant for mechanical clearance from compartment 5 to 7 (bb2 to BB1).
LOGNORMAL: [0.03, 1.73]
7) c6,10: Rate constant for mechanical clearance from compartment 6 to 10 (bbseq to LNth)
LOGNORMAL: [0.01, 1.73]
8) c7,11: Rate constant for mechanical clearance from compartment 7 to 11 (BB1 to ET2).
LOGNORMAL: [10, 1.22]
9) c8,11: Rate constant for mechanical clearance from compartment 8 to 11 (BB2 to ET2).
LOGNORMAL: [0.03, 1.73]
10) c9,10: Rate constant for mechanical clearance from compartment 9 to 10 (BBseq to LNt
LOGNORMAL: [0.01, 1.73]

Double-click on quantity to change distribution characteristics. All rates are in units of 1/days.

FIG. 12

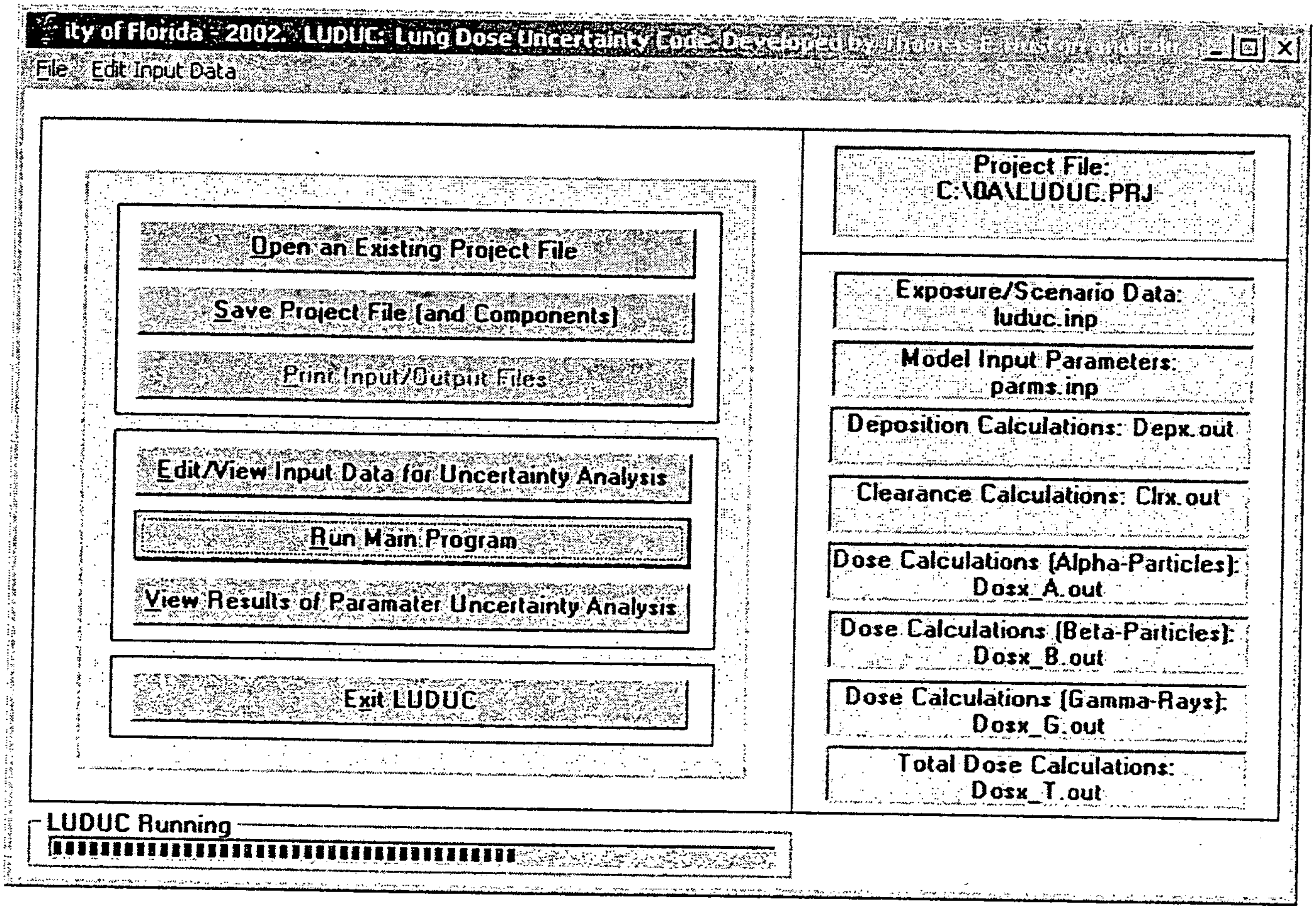


Quantity, Distribution Type, and Distribution Parameters

1) BB: Mucus/gel layer thickness (um, BB1+BB1T).
TRIANGULAR: [4, 6, 8]
2) BB: Cilia/sol layer thickness (um, BB2+BB2T).
TRIANGULAR: [4, 7.5, 10]
3) BB: Epithelium thickness (um).
UNIFORM: [25, 60]
4) BB: Macrophage layer (Sequestered material, BBseq+BBseqT) thickness (um).
UNIFORM: [5, 15]
5) BB: Macrophage layer (Sequestered material, BBseq+BBseqT) depth (um) w.r.t. basement
UNIFORM: [0, 10]
6) BB: Secretory cell nuclei layer depth (um, w.r.t. epithelium surface).
UNIFORM: [5, 15]
7) BB: Basal cell nuclei layer thickness (um).
UNIFORM: [10, 20]
8) bb: Mucus/gel layer thickness (um, bb1+bb1T).
UNIFORM: [1, 3]
9) bb: Cilia/sol layer thickness (um, bb2+bb2T).
UNIFORM: [3, 6]
10) bb: Epithelium thickness (um).
UNIFORM: [10, 20]

Double-click on quantity to change distribution characteristics. All tissue dimensions are in units of

FIG. 13



ity of Florida - 2002. LUDUC: Lung Dose Uncertainty Code- Developed by Thomas E. Huston and
File
Edit Input Data
Open an Existing Project File
Save Project File (and Components)
Print Input/Output Files
Edit/View Input Data for Uncertainty Analysis
Run Main Program
View Results of Paramater Uncertainty Analysis
Exit LUDUC
LUDUC Running

Project File: C:\QA\LUDUC.PRJ

Exposure/Scenario Data: luduc.inp

Model Input Parameters: parms.inp

Deposition Calculations: Depx.out

Clearance Calculations: Clrx.out

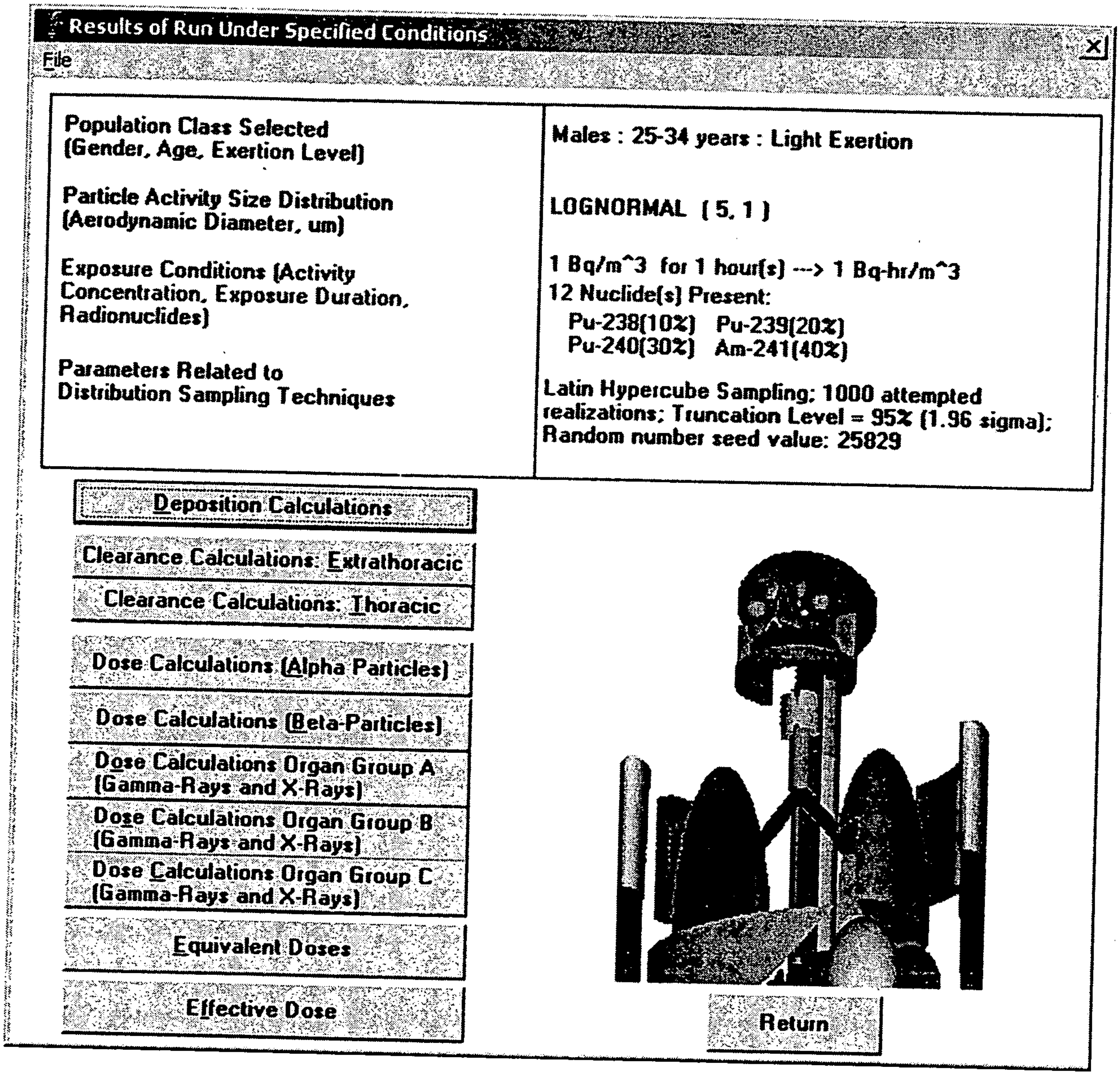
Dose Calculations (Alpha-Particles): Dosx_A.out

Dose Calculations (Beta-Particles): Dosx_B.out

Dose Calculations (Gamma-Rays): Dosx_G.out

Total Dose Calculations: Dosx_T.out

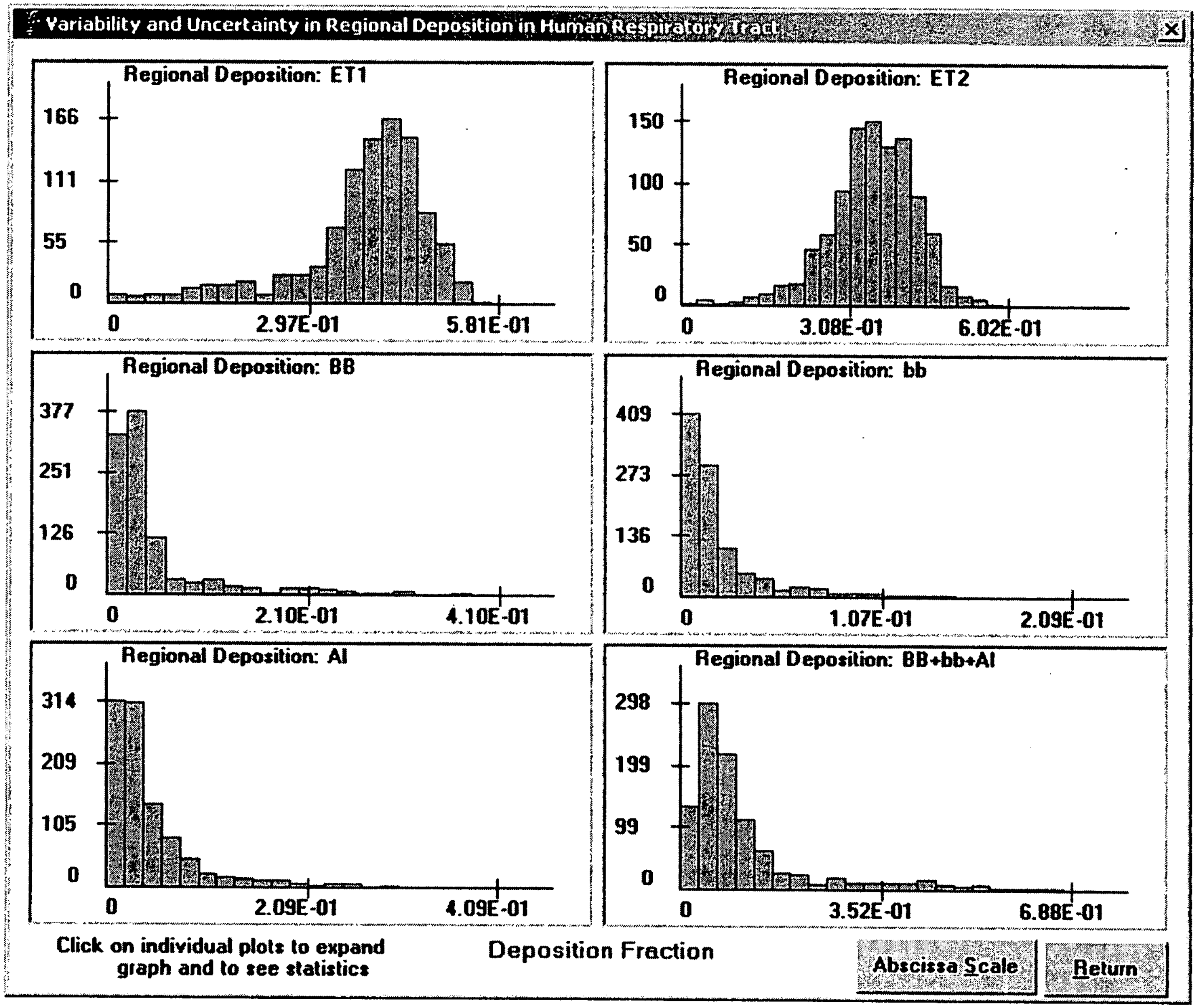
FIG. 14


File
Deposition Calculations
Clearance Calculations: Extrathoracic
Clearance Calculations: Thoracic
Dose Calculations (Alpha Particles)
Dose Calculations (Beta-Particles)
Dose Calculations Organ Group A (Gamma-Rays and X-Rays)
Dose Calculations Organ Group B (Gamma-Rays and X-Rays)
Dose Calculations Organ Group C (Gamma-Rays and X-Rays)
Equivalent Doses
Effective Dose
Return

Results of Run Under Specified Conditions

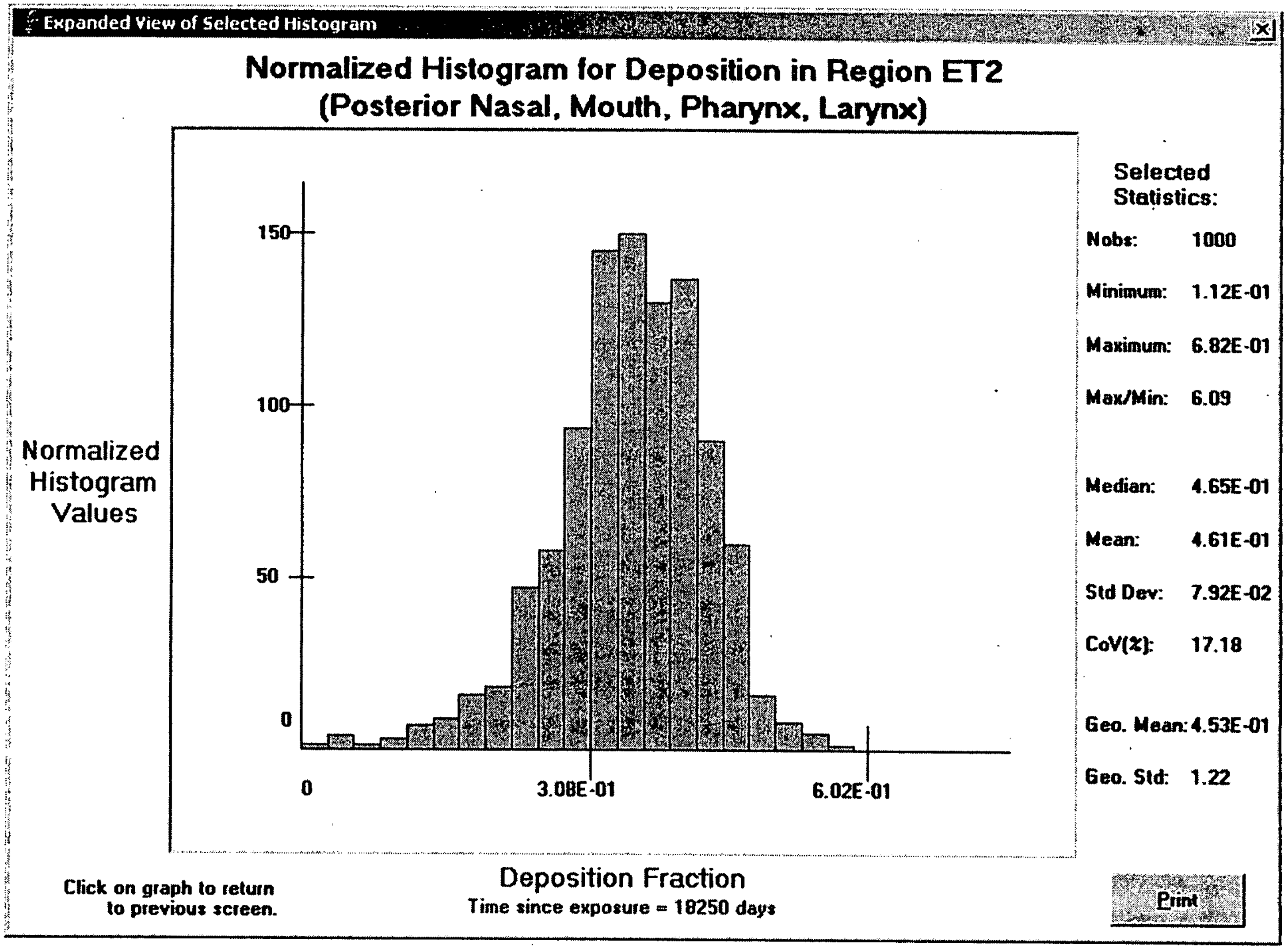
Population Class Selected (Gender, Age, Exertion Level)	Males : 25-34 years : Light Exertion
Particle Activity Size Distribution (Aerodynamic Diameter, um)	LOGNORMAL (5, 1)
Exposure Conditions (Activity Concentration, Exposure Duration, Radionuclides)	1 Bq/m^3 for 1 hour(s) ---> 1 Bq-hr/m^3 12 Nuclide(s) Present: Pu-238(10%) Pu-239(20%) Pu-240(30%) Am-241(40%)
Parameters Related to Distribution Sampling Techniques	Latin Hypercube Sampling; 1000 attempted realizations; Truncation Level = 95% (1.96 sigma); Random number seed value: 25829

FIG. 15



Click on individual plots to expand
graph and to see statistics

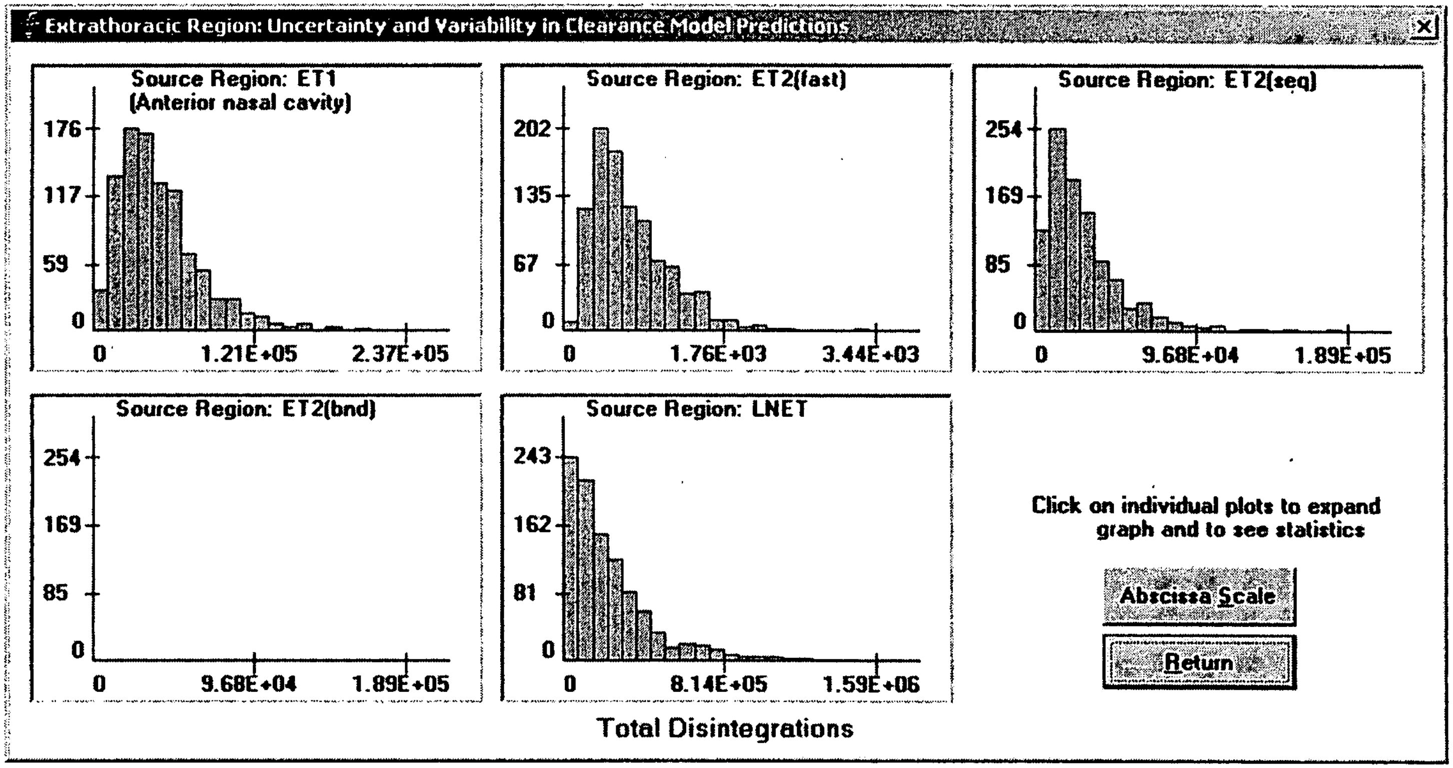
FIG. 16


Expanded View of Selected Histogram
Normalized Histogram for Deposition in Region ET2
(Posterior Nasal, Mouth, Pharynx, Larynx)
Normalized Histogram Values
150
100
50
0
0
3.08E-01
6.02E-01
Deposition Fraction
Time since exposure = 18250 days
Click on graph to return to previous screen.
Print

Selected Statistics:

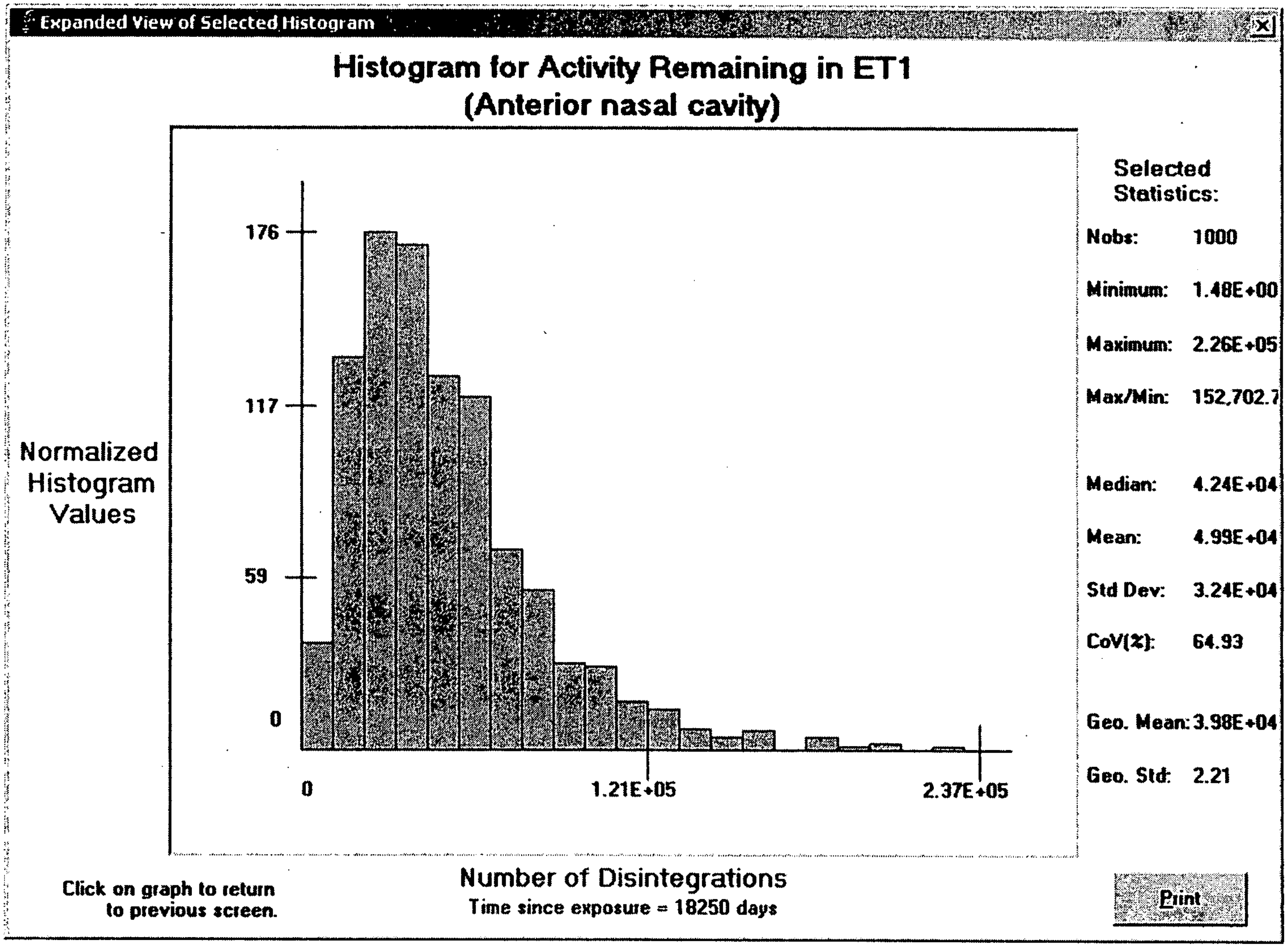
Nobs:	1000
Minimum:	1.12E-01
Maximum:	6.82E-01
Max/Min:	6.09
Median:	4.65E-01
Mean:	4.61E-01
Std Dev:	7.92E-02
CoV(%):	17.18
Geo. Mean:	4.53E-01
Geo. Std:	1.22

FIG. 17



Click on individual plots to expand graph and to see statistics

FIG. 18


Expanded View of Selected Histogram
Histogram for Activity Remaining in ET1
(Anterior nasal cavity)
Normalized
Histogram
Values
176
117
59
0
0
1.21E+05
2.37E+05
Number of Disintegrations
Time since exposure = 18250 days
Click on graph to return
to previous screen.
Print

Selected
Statistics:

Nobs: 1000

Minimum: 1.48E+00

Maximum: 2.26E+05

Max/Min: 152,702.7

Median: 4.24E+04

Mean: 4.99E+04

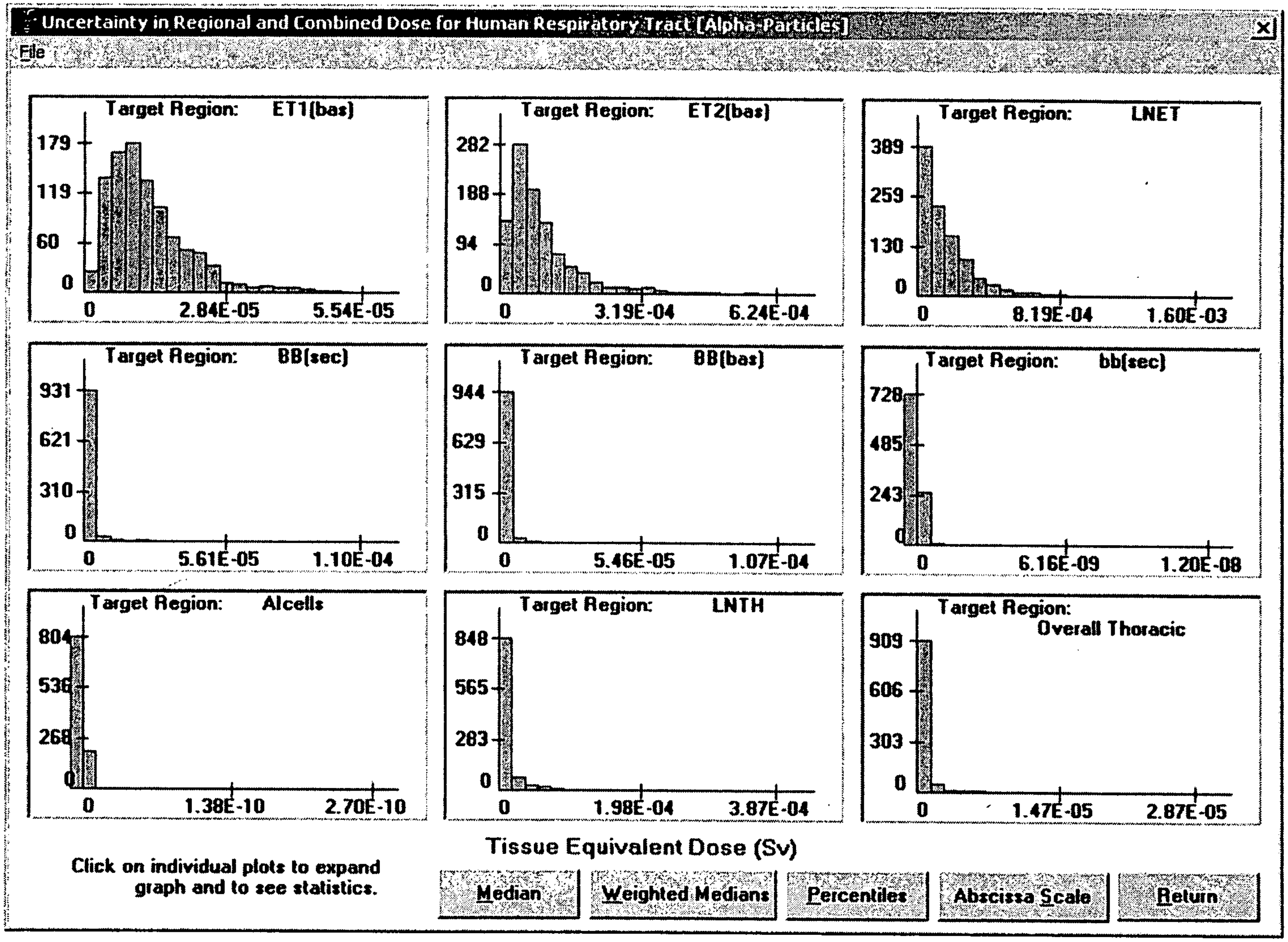
Std Dev: 3.24E+04

CoV(%): 64.93

Geo. Mean: 3.98E+04

Geo. Std: 2.21

FIG. 19



Click on individual plots to expand graph and to see statistics.

FIG. 20

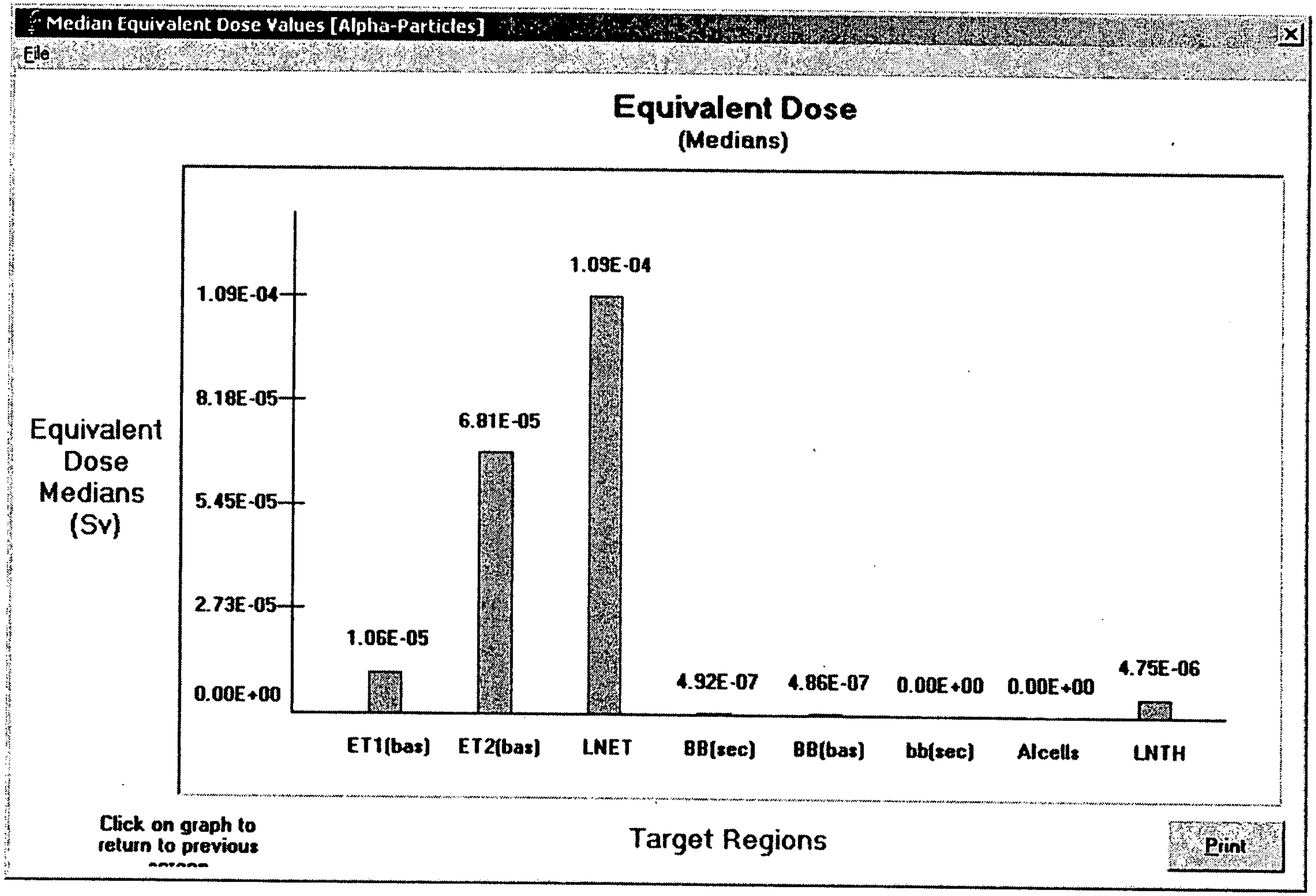
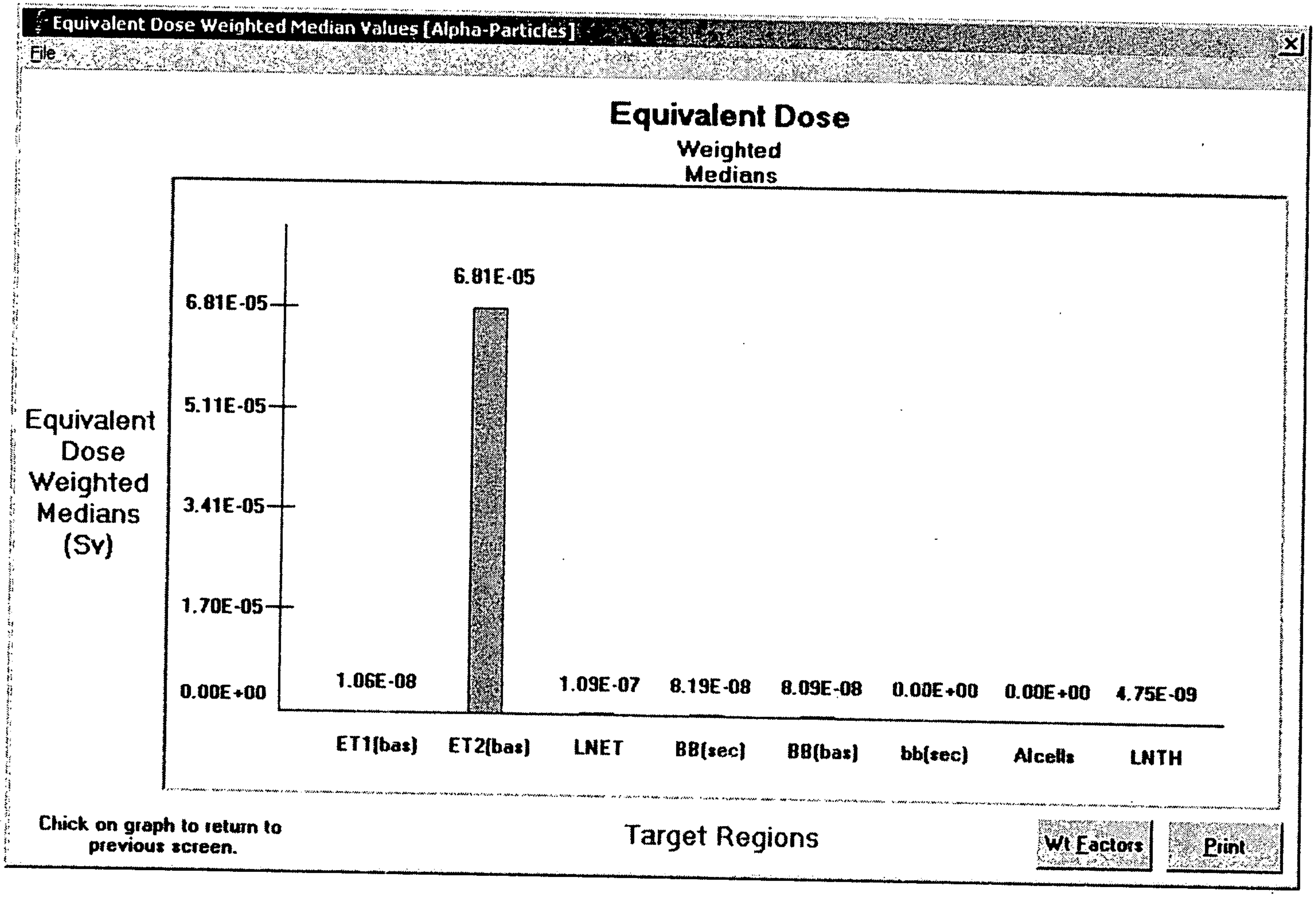
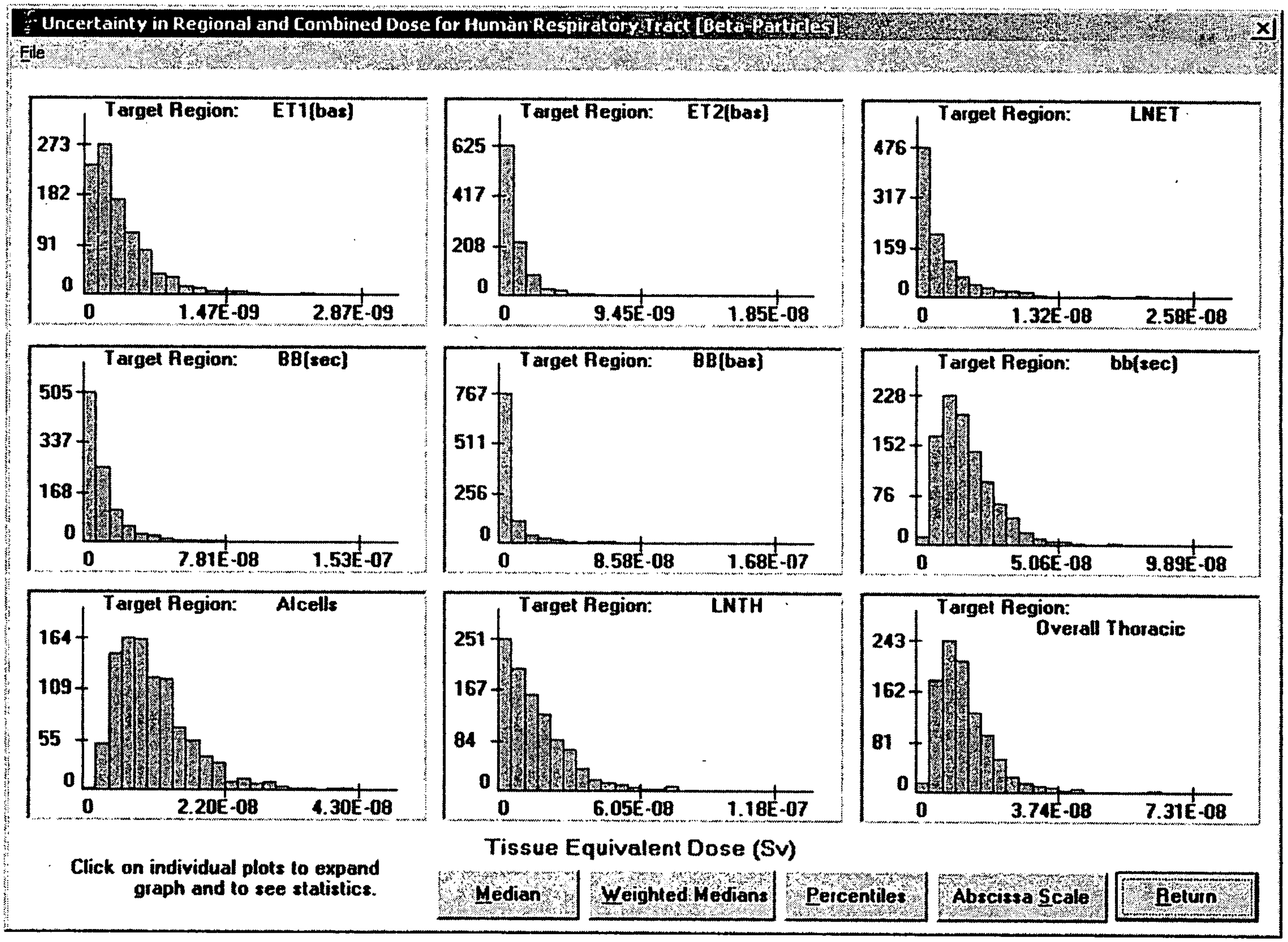
Median Equivalent Dose Values [Alpha-Particles]
File
Equivalent Dose
(Medians)
Equivalent Dose Medians (Sv)
1.09E-04
8.18E-05
5.45E-05
2.73E-05
0.00E+00
1.06E-05
6.81E-05
1.09E-04
4.92E-07
4.86E-07
0.00E+00
0.00E+00
4.75E-06
ET1(bas)
ET2(bas)
LNET
BB(sec)
BB(bas)
bb(sec)
Alcells
LNTH
Target Regions
Click on graph to
return to previous
Print

FIG. 21


Equivalent Dose Weighted Median Values [Alpha-Particles]

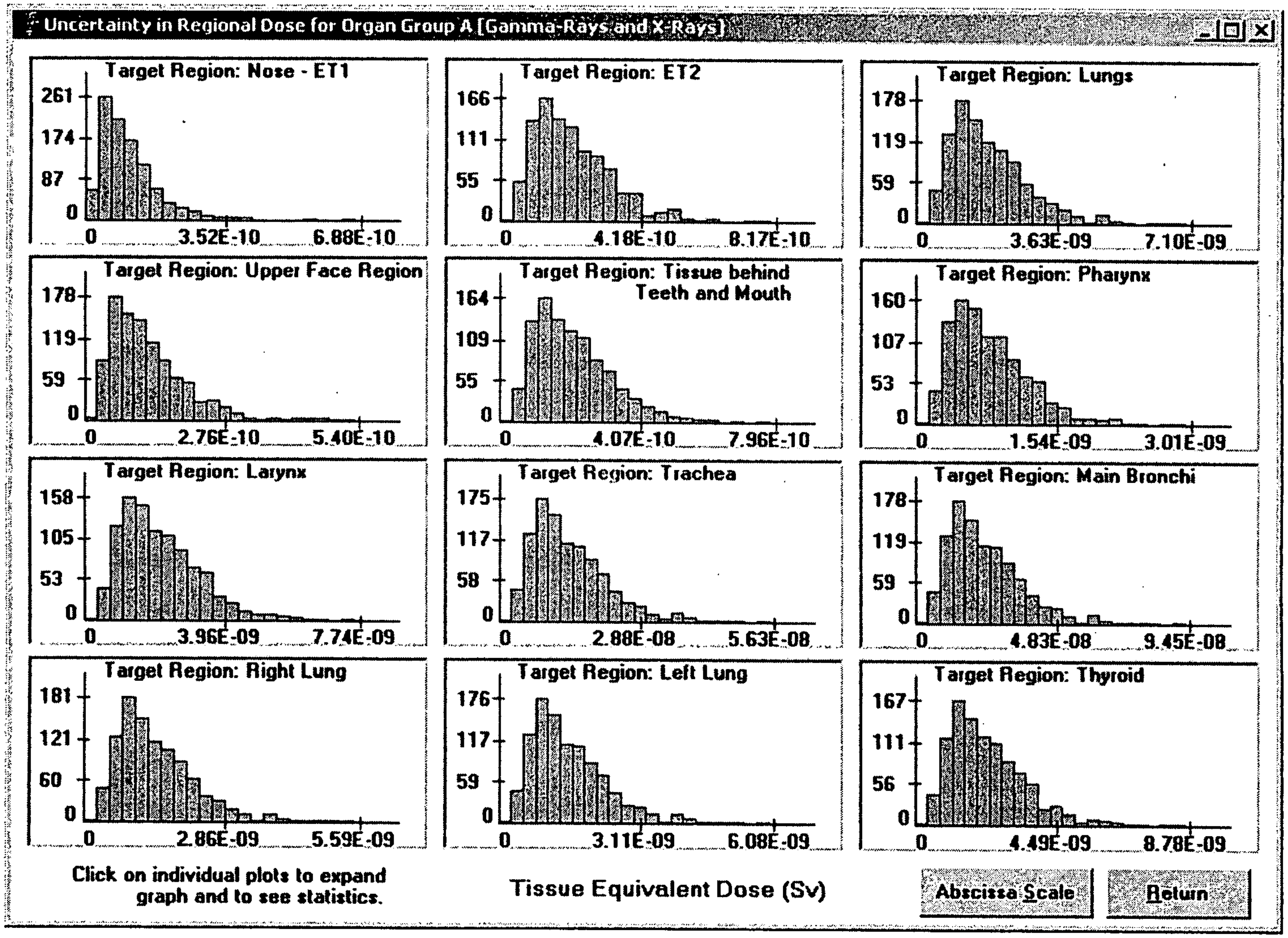
Chick on graph to return to previous screen.

FIG. 22



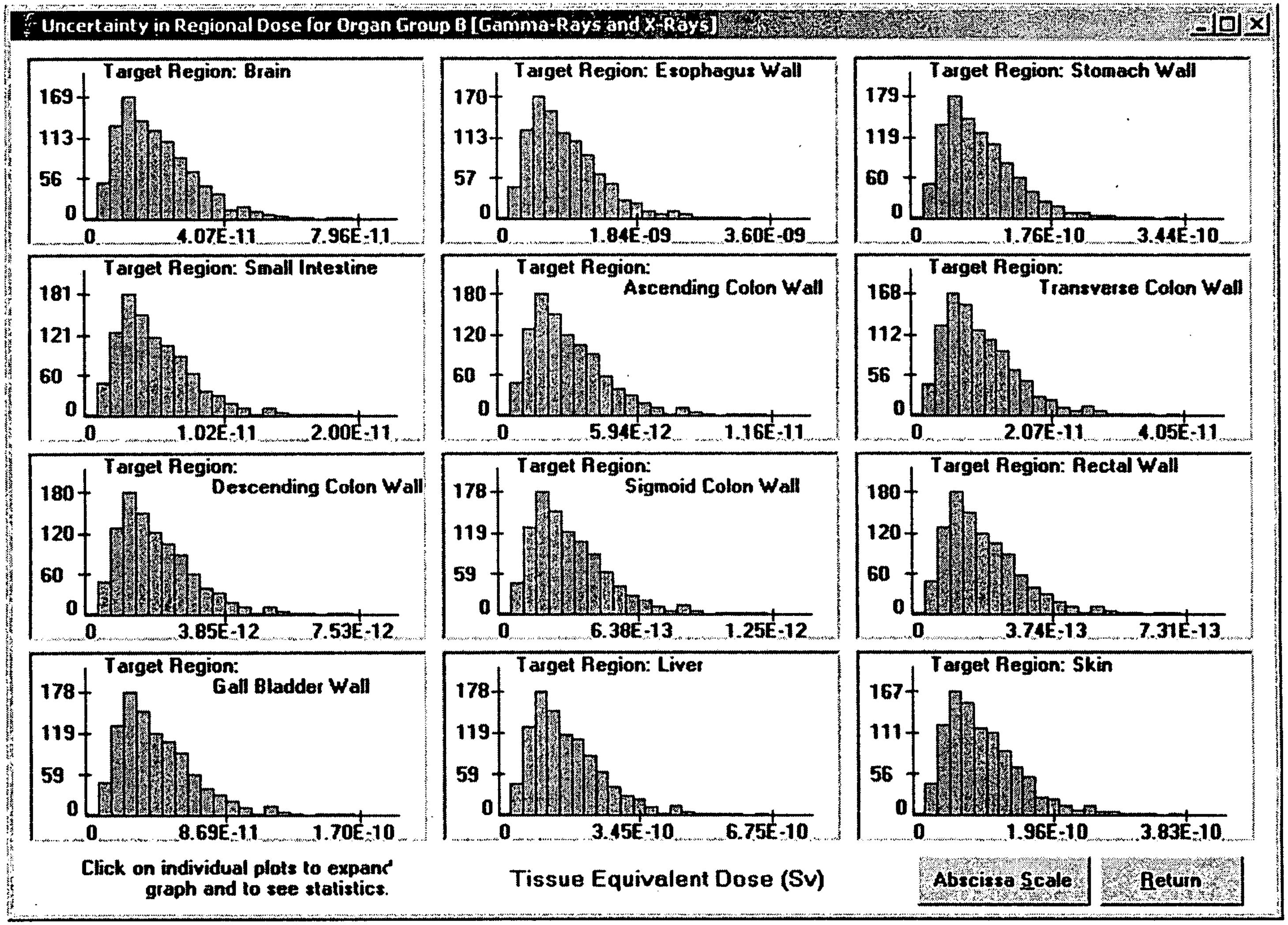
Click on individual plots to expand graph and to see statistics.

FIG. 23



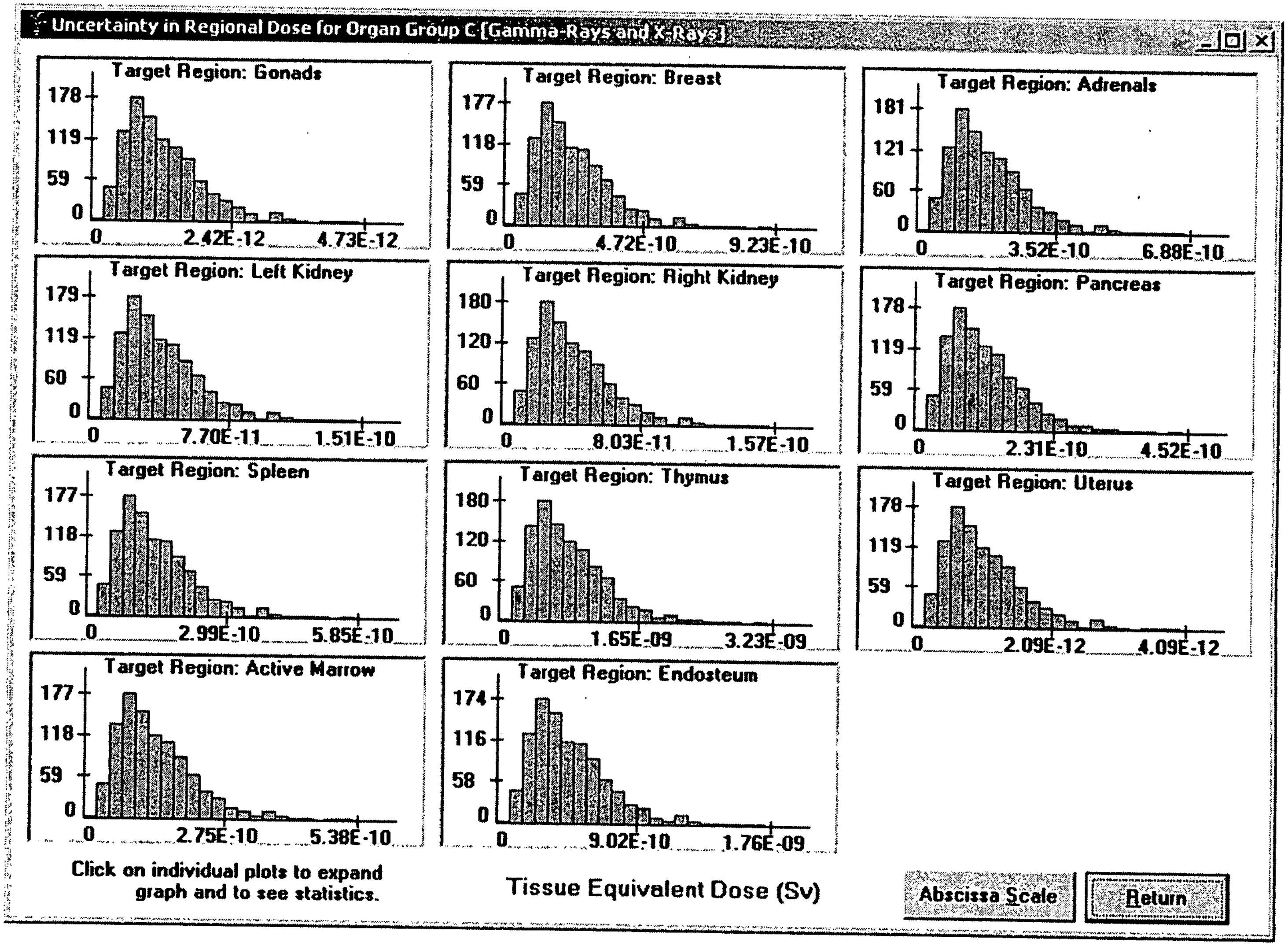
Click on individual plots to expand graph and to see statistics.

FIG. 24



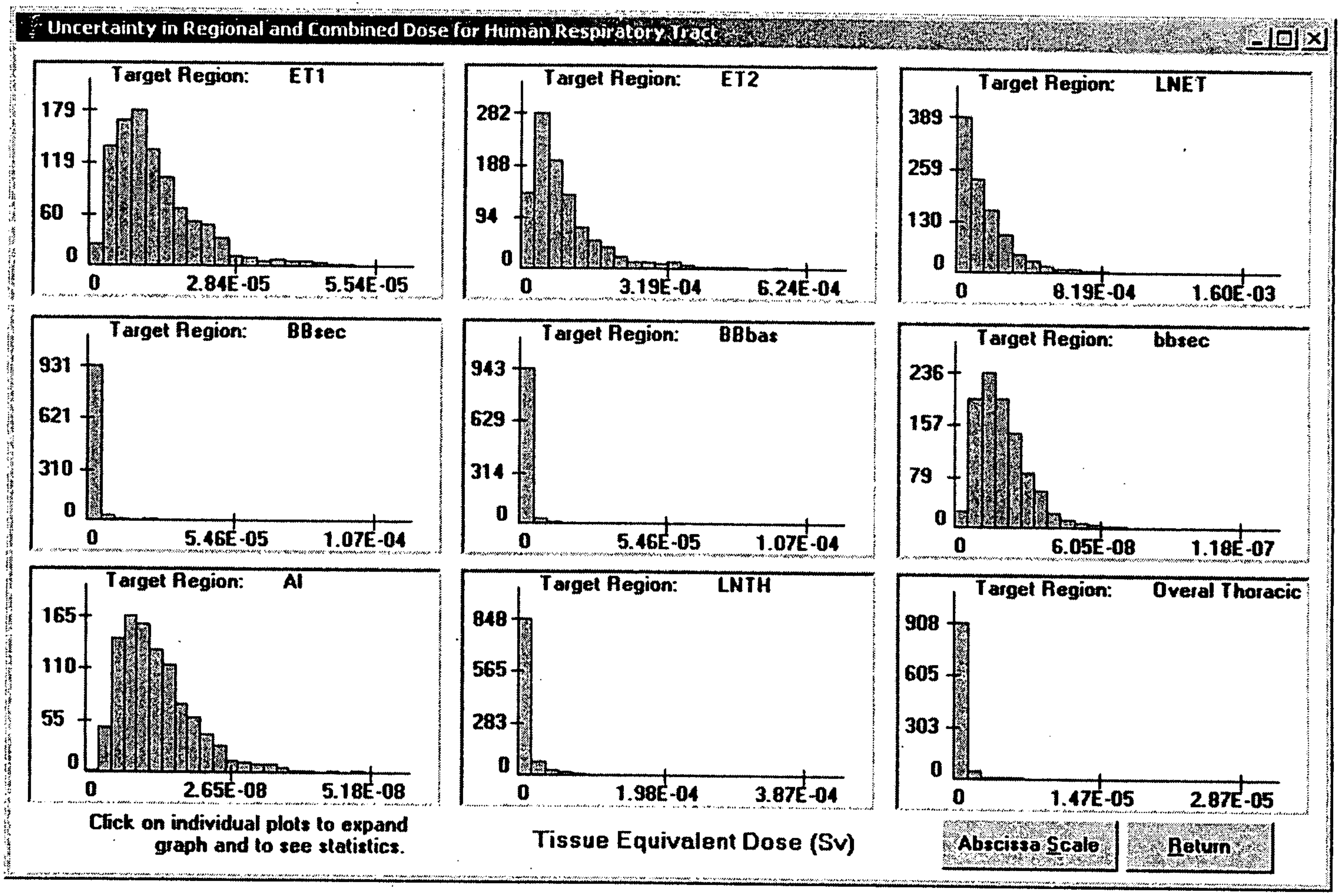
Click on individual plots to expand graph and to see statistics.

FIG. 25


Uncertainty in Regional Dose for Organ Group C (Gamma-Rays and X-Rays)

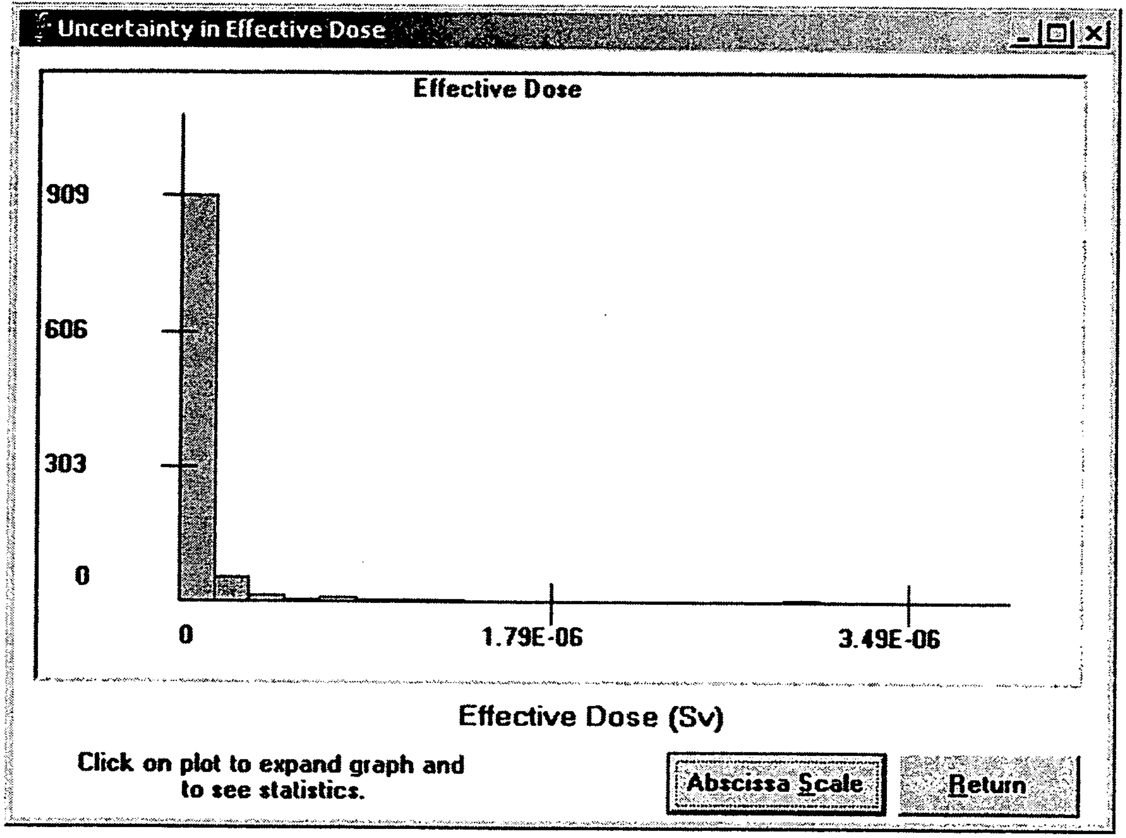
Click on individual plots to expand graph and to see statistics.

FIG. 26



Click on individual plots to expand graph and to see statistics.

FIG. 27



Click on plot to expand graph and
to see statistics.

FIG. 28